REMARKS

Claim Objections

The examiner objected to **claims 5, 7 and 8** and kindly made suggestions for changes. Applicant has made the suggested changes and thanks the examiner for the suggestions.

Claim Rejections - 35 USC §112

In regard to claim 7, the examiner objected to the term "thermal load" for the reasons stated in the office action. The examiner is correct that the term as originally used in claim 7 was intended to refer to the mass that provides the thermal load because it is the mass from which heat is drawn. The use of that term in that manner sounds correct to the ear of applicant's attorney, probably because his undergraduate degree was in electrical engineering. There the term "load" is commonly used both to refer to the device that draws electrical power from the circuit as well as the electrical power that is drawn by the electrical load device. In the claim, "thermal load" was used to refer to the mass from which heat is drawn as the examiner correctly observed. However, applicant's attorney accepts the examiner's comments and has revised claim 7 to provide the meaning that was apparent to the examiner from the specification based upon the examiner's knowledge in the field. Specifically, applicant has substituted "thermal mass providing a thermal load" for the term "thermal load". This is the same structure as the "mass being cooled by the cryocooler" in claim 8.

In regard to claim 8, the examiner stated that the term "actuating signal" as used creates confusion because it "is unclear whether this refers to the previous actuating signal cited in the claim or not." The confusion is understandable and applicant has amended the claim to remove the confusion. However, an explanation is believed necessary. The confusion arose because the actuating signals to the two parallel dynamic legs can be the same signal or they can be two different signals. As explained in paragraphs [0018] through [0020], the first actuating signal is the signal applied to the input 18 of the first dynamic branch. As explained in paragraph [0021], the second actuating signal is the input to the second, parallel dynamic branch and is preferably the output 20 from component 16. However, as explained, beginning in paragraph [0021] at line 22, page 9, the input to the second, parallel, dynamic branch can alternatively be derived from the input T_E , which is the actuating input 18 to the first dynamic branch. Therefore, claim 8 was intended to cover both alternatives. Applicant has amended claim 8 in an attempt to remove any lack of clarity.

Claim Rejections - 35 USC §103

Although the invention is described in more detail by the claims, it can be summarized as follows. The invention is the combination of: (1) a first dynamic branch of a control system that modulates piston stroke as a function of temperature whenever the piston stroke called for by the stroke modulator is above a selected minimum stroke and maintains the piston stroke at the minimum piston stroke whenever the piston stroke called for by the stroke modulator is less than the selected minimum piston stroke; and

(2) a second, parallel dynamic branch that applies heat as a function of temperature whenever the piston stroke called for by the stroke modulator is less than the selected minimum piston stroke.

With respect to the Wu et al. reference, the examiner correctly observes that Wu et al. modulates piston stroke as an increasing function of the temperature difference between the sensed mass temperature and the command reference input temperature. However, the examiner seems to refer to Wu et al. as having a selected minimum piston stroke. It may be that applicant's attorney does not understand that statement by the examiner, but applicant's attorney finds no minimum piston stroke in Wu et al. A word search of the Wu et al. text finds no use of the word "minimum" or the word "boundary", either of which might have been used to describe a minimum stroke.

The examiner does not point to any part of the Wu et al. reference as teaching a minimum piston stroke. Instead, the examiner says that Wu's selected minimum piston stroke is that stroke length which would maintain the cooling power output of the cryocooler. In the office action, page 7, line 7, the examiner inserts the word "current" before "cooling power output" for the same concept. That sounds to applicant's attorney as if the examiner is saying that the minimum stroke of Wu et al. is whatever stroke the Wu et al control system currently selects based upon the temperature difference between the sensed mass temperature and the command reference input temperature. If that understanding is correct, applicant respectfully submits that the examiner is giving a different meaning to the term "minimum" than would ordinarily be given and a very different meaning from the meaning used by applicant. The current cooling power output

of Wu et al is a dynamically changing variable that changes as a function of the temperature difference. It is apparent from applicant's description of applicant's invention that a selected, minimum piston stroke is a fixed or constant value of piston stroke chosen to maintain gas bearing lubrication. That constant characteristic is inherent or implicit in the term "minimum", and more certainly by the term "selected minimum" and is what is illustrated in applicant's Fig. 2 at vertical line A. Applicant respectfully urges that it would be an unreasonable use of the term "minimum" to apply it to a dynamically changing parameter like the stroke called for by Wu et al, which is dynamically changing as a function of the above temperature difference. Wu et al does not have a selected minimum. Wu et al simply varies the stroke.

Therefore, while the examiner correctly observed that Wu et al. modulates piston stroke as a function of temperature difference, the Wu et al. reference does not disclose any "selected minimum piston stroke".

With respect to Gully et al., the examiner first observes that "Wu et al. does not teach maintaining a selected minimum piston stroke length if the piston drive signal calls for a stroke length less than a minimum piston stroke length." This statement by the examiner is exactly correct.

The examiner then observed that Gully et al. teach maintaining a minimum piston stroke length and quotes a passage from the Gully et al. reference to support that observation. However, Gully et al. does not teach a minimum stroke length. The passage quoted by the examiner is something quite different.

The fact that Gully et al. do not teach a minimum stroke is best illustrated by a quote from the Gully et al. reference (column 4, lines 3-6): "there is no limit on the range of compressor piston stroke within the mechanical limits of the length of the stroke, i.e. from minimum stroke, including zero stroke, to the maximum stroke length." Gully et al. makes it clear that there is no minimum stroke because the stroke can even be zero, i.e. non-existent.

The quotation cited by the examiner is something different from a minimum. Gully et al. is disclosing that, when the sensed temperature equals the command reference temperature, he still wants some stroke to provide sufficient cooling to compensate for thermal losses, such as heat input through insulation from the surrounding environment. That is what Gully et al. says (col. 4, lines 50-52). Gully et al. has an offset in the amount to those thermal losses. However, it is clear from Gully et al. that, if the sensed temperature becomes less than the command reference temperature, the stroke will be reduced further. That is a necessary consequence of the stroke being a function of temperature difference. In fact he makes it clear from the passage quoted above, that the stroke can be reduced to zero. Therefore, Gully et al. does not teach a minimum stroke.

With respect to Dehne, the examiner first observed that Wu et al. "do not teach applying thermal energy to the mass when the piston drive signal is less than the selected minimum piston stroke. The examiner then observes that Dehne teaches the historical use of electrical heaters to control the temperature of temperature-sensitive electronics on the cold end". Applicant agrees that the examiner accurately characterizes the teaching of Dehne. The prior art has heated the cold end of a cooler to control temperature. However,

Dehne teaches nothing about any relationship or cooperation of a control system that uses heating with a control system that uses piston stroke modulation.

Consequently, in view of the prior art, the invention as now claimed in **independent claims 1, 5, 7 and 8** is patentable for at least the following reasons.

First, although temperature control by stroke modulation and temperature control by heating are each separately disclosed in the prior art, no prior art has combined them or shown any way to combine them. Furthermore, the prior art does not teach any reason or motivation to combine them.

Second, applicant has not only found a way to combine stroke modulation and heating to control the temperature of a cooled mass, applicant's way is to select a boundary value of stroke which is called the selected minimum stroke. Applicant combines the concepts of:

(1) for strokes called for by the control system that are above that boundary, applying stroke modulation; and

(2) for strokes called for by the control system that are below that boundary,

(a) maintaining the stroke at the boundary value (the "selected minimum stroke"); and

(c) applying heat.

Nowhere in the prior art is there any teaching or motivation for a boundary value of stroke, for the use of stroke modulation above the boundary, for the maintenance of the boundary value of stroke when the control system calls for a lower stroke or for the application of heat when the control system calls for a lower stroke. None of these is

shown alone and, more importantly, there is no teaching to combine them with the relationships and cooperation described in the claims.

Claim 2 and claim 6 are directed to the value of the boundary stroke. Claims 2 and 6 say that the selected minimum piston stroke value is the stroke necessary to maintain the gas bearing lubrication. No prior art teaches anything about selecting a minimum stroke in such a control system on that basis and the examiner did not say it does. The examiner said that Gully et al. teaches preventing piston collision but piston collision involves a selected maximum piston stroke, not a selected minimum piston stroke. A word search of the Gully et al. text by applicant's attorney found no use of the words "collision", "colliding" or "damage". Nonetheless, applicant concedes that there is prior art that has means to prevent piston collisions. But piston collision has nothing to do with the invention as claimed, because limiting piston stroke to below a maximum stroke in order to prevent piston collisions is known and is not the subject of applicant's claims. Applicant's claims are directed to maintaining piston stroke above a minimum under a specific condition.

With respect to claim 3, the examiner observes that Dehne inherently teaches increasing the heater power as an increasing function of the difference between the cooling power of the cryocooler and the cooling power demand. Although heating systems generally in other contexts undoubtedly have, as the examiner stated, controlled heating in proportion to a temperature difference, that is not necessarily inherent in Dehne. The reason is that another popular way of controlling heat is to simply turn the heater fully on when more heat is called for and to turn the heating power off when less

heat is called for by the control system. Dehne does not disclose or teach either way and could very well have contemplated the latter.

Further in regard to claim 7, the examiner observed, in the middle of page 7 of the office action, that Wu et al. teaches either using a heater or stroke control. That is accurate so long as the examiner understands that this comment in Wu et al. (col. 1, lines 54-61) is a discussion of the prior art and Wu et al. is pointing out the problems with using a heater and is saying that instead of a heater, his stroke control is better. Wu et al., with regard to the heater teaching, teaches no more than Dehne. Both teach heating as a separate and alternative way of controlling temperature. Neither teaches or suggests combining both or how to combine both. Wu et al. teaches away from applicant's invention and supports applicant's above arguments because Wu et al. recognizes these as alternative control systems, stroke control and heating, but merely says one is better, giving no hint that they might be combined or of a way to combine them.

The examiner also observed on page 7 of the office action that the power from these heaters "can be modulated" as an increasing function of the temperature difference. But that does not make it obvious to do so as made clear in the MPEP at 2143.01 III. There the MPEP says "The mere fact that references can be combined **or modified** does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." Neither Wu et al. nor Dehne make such a suggestion. Wu et al. in fact say instead use stroke control.

The examiner observed near the bottom of page 7 of the office action that it is well known that, when modulating the piston stroke length of a compressor, the

operational limits of the compressor must be maintained to prevent damage and "to maintain the compressor function at a level at least tending to compensate thermal losses". Applicant agrees with both of those observations. However, the first observation is directed to maintaining the stroke below a maximum stroke so there are no collisions. That has nothing to do with maintaining a minimum stroke and nothing to do with maintaining a minimum stroke in order to maintain a sufficient gas flow to maintain gas bearing operation as applicant does.

The examiner's second observation is also not related to a minimum stroke as partially discussed above. The Gully et al. quote is directed not to a minimum stroke, but is directed to maintaining a stroke when the sensed temperature is equal the commanded reference temperature that provides the amount of cooling power needed to compensate for thermal losses. That stroke is a selected stroke for use when those temperatures are equal. Gully et al. says in many places, including the abstract, that the piston stroke is varied as a direct function of the cryocooler temperature. It obviously follows that, when the cryocooler temperature falls below the command reference temperature, the stroke will become less than the stroke needed "to compensate thermal losses". It is obviously desirable to do that. Consequently, the amount of stroke to compensate for thermal losses is not a minimum because the stroke will, under those conditions, become less.

Further in regard to claim 8, some of the subject matter of the above comments are applicable to claim 8 and therefore are not repeated here. With respect to the limiter, there is no reference to limiting in the Gully et al. device except for the above quote "there is no limit on the range of compressor piston stroke" (col. 4, line 3). Furthermore,

Gully et al.'s piston stroke corresponding to his V_{TE} is not a minimum but is a stroke length to provide cooling power to compensate for thermal losses as stated by Gully et al. and explained above. For the reasons also explained above, the Gully et al. stroke can be less than the stroke corresponding to his V_{TE} and in fact, as stated by Gully et al. can be "zero stroke" (col. 4, lines 5-6).

Finally, on page 9 of the office action the examiner concludes that, because Wu et al. teaches a dynamic leg for controlling piston stroke and Dehne teaches a dynamic leg for control by heating, it would have been obvious to:

1. combine the two legs to provide two parallel dynamic legs;

and also obvious to

2. when the actuating signal is greater than a selected minimum piston stroke, apply no heating power;

and

3. when the actuating signal is less than the selected piston stroke, to add heating power as a decreasing function of the actuating signal.

First, maintaining the minimum piston stroke is also an important part of applicant's combination.

More importantly, this rejection cites no teaching in the prior art that would make combining these two dynamic legs obvious. The examiner suggests a motivation for the combination to be "raising the temperature of the cold end faster than by piston modulation without adding undue heat to the cold end when piston modulation is sufficient". Applicant respectfully submits that this is a clear hindsight creation of a

motivation that has no basis in the prior art. No prior art gives any hint that piston modulation would be too slow. To the contrary, piston modulation is advocated as satisfactory by Wu et al. and by Gully et al. Wu et al. actually describes the unsatisfactory consequences of applying heat. Nothing in the prior art suggests that a minimum stroke should be maintained when heat is applied. Temperature control by piston modulation and temperature control by applying heat are taught in the prior art as two alternative, separate ways to control temperature.

In conclusion and in summary, the invention as defined in the claims is not merely combining temperature control by controlling stroke with temperature control by heating, although that combination is not itself taught or suggested or motivated by anything in the prior art. Very importantly, the invention further includes combining them by selecting a finite minimum stroke for use as a boundary, using only stroke control above that minimum stroke, using only heat control below that minimum stroke, and maintaining the stroke at the minimum stroke when the heat control is used. Although stroke control and heat control are separately taught in the prior art as alternative, independent ways to control temperature, no prior art gives any reason or motivation to combine them, no prior art gives any idea how to combine them and especially no prior art gives a hint at the use of the minimum stroke as a boundary between them or maintaining the minimum stroke when the heat control is used. It is the combination of all these important limitations that is applicant's invention.

It may be that this application needs an interview. Applicant would be pleased to have an opportunity to have an interview with the examiner to discuss this patent

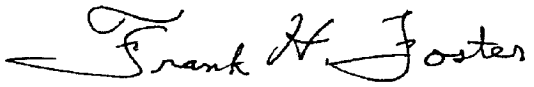
application and cited prior art. Applicant therefore requests that the examiner call the undersigned attorney in the event that anything is unclear or if the examiner believes that an interview would be helpful.

Reconsideration and allowance are respectfully requested.

The examiner is authorized to communicate with the undersigned attorney by email by the following recommended authorization language: Recognizing that Internet communications are not secure, I hereby authorize the USPTO to communicate with me concerning any subject matter of this application by electronic mail. I understand that a copy of these communications will be made of record in the application file. (Authorization pursuant to MPEP 502.03.)

The Commissioner is authorized to charge Deposit Account No. 13-3393 for any insufficient fees under 37 CFR §§ 1.16 or 1.17, or credit any overpayment of fees.

Respectfully submitted,



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